FACTSHEET FOR PARTNERSHIP FIELD VALIDATION TEST

Partnership Name	Southeast Regional Carbon Sequestration Partnership (SECARB)		
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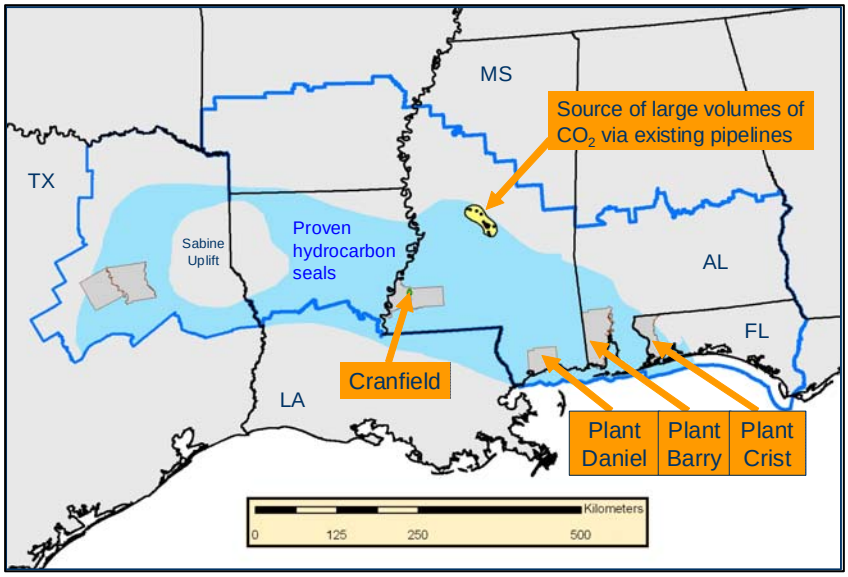
Field Test Information: Field Test Name	SECARB Phase III Tuscaloosa Formation CO_2 Storage Project	
Test Location	Early Test – Cranfield Oilfield Anthropogenic Test – Southern Company Electric Generating Facility	
Amount and Source of CO_2	Tons	Source
Early Test	*1.5 million tons/year*	*Denbury Resources (Natural)*
Anthropogenic Test	*100,000 to 250,000 metric tons/year*	*Power Plant CO_2 – Anthropogenic Test*
Field Test Partners (Primary Sponsors)	Texas Bureau of Economic Geology, Denbury Resources, Advanced Resources International, Inc., The Electric Power Research Institute	

Summary of Field Test Site and Operations
Early data collection, through Phase II efforts, has shown that the Lower Tuscaloosa Massive Sand Unit is a large, regionally extensive saline formation with potential to hold centuries of CO_2 emissions in the Southeast. SECARB's Phase III project will further test this geologic formation at two sites: 1) the Cranfield Oilfield, located near Natchez, Mississippi (the "Early Test"); and 2) at a Southern Company CO_2 capture test location (the "Anthropogenic Test").

Figure 1. Geographic Location of SECARB Phase III Program



The Early Test will be conducted in Adams and Franklin Counties, Mississippi, about 15 miles east of Natchez and 1.5 miles north of the unincorporated city of Cranfield (**Figure 1**). The area selected for the Early Test is immediately north of the SECARB Phase II "Stacked Storage" study underway in the oil rim. The area is heavily wooded and hilly, elevation 200-400 feet, with flat terrace areas near streams. Land use is rural; timber production, gravel quarrying, and oil production are important

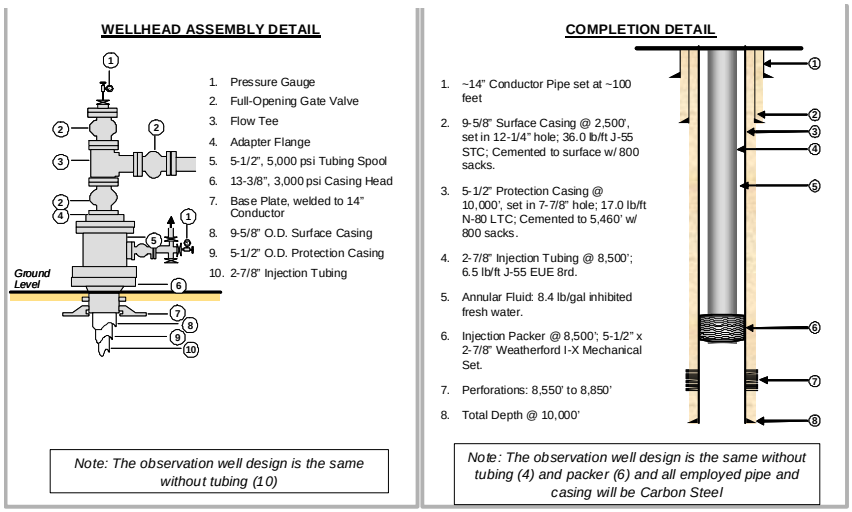
industries as well as some farming. U.S. Route 61 and U.S. Route 84 provide highway access to the area. A network of county and private gravel roads provides access to well sites. The area is hilly upland with no mapped wetland. No significant water bodies are found in the study area. South Coles Creek provides surface drainage. Critical habitats or wildlife refuges for any of the listed species of plants or wildlife do not exist in the vicinity of the project site. The closest wildlife refuge is the St. Catherine Creek National Wildlife Refuge. St. Catherine's is located approximately 20 miles southwest of the project area on the east bank of the Mississippi River which is 10 miles south of the city of Natchez.

For the Early Test, The Bureau of Economic Geology (BEG) will partner with Denbury Resources, Incorporated, to take advantage of ongoing CO_2-EOR efforts by the field operator. This presents SECARB with the opportunity to inject approximately 1.5 million tones of CO_2, over 1.5 years, in the down-dip water leg of an oil reservoir in order to test a bevy of commercial and experimental MMV protocols. This shorter duration, large volume injection test will provide important data in preparation for SECARB's longer duration injection efforts associated with the Anthropogenic Test, to be carried out by Southern Company, the Electric Power Research Institute and Advanced Resources International, Incoporated.

The Anthropogenic Test will be conducted on or in proximity to a Southern Company plant site on the Gulf Coast, **Figure 1**. Data confirms that the test sites are regionally similar to the geologic setting of the larger Gulf Coast area. Southern Company will negotiate site access agreements with appropriate contractors to perform the project on the selected Southern Company plant site. Should a storage site other than that owned and maintained by Southern Company be required, the project team will obtain appropriate access.

For the Anthropogenic Test, the site development design will be linked to the daily rate of delivered CO_2. Capture volumes, from an as yet to be determined CO_2 capture method, are anticipated to range from 100,000 to 250,000 metric tons per year. It is anticipated that one injection well will be sufficient to handle these daily volumes. If higher injection rates are necessary, the project team will use two vertical injection wells to inject the CO_2 into the Lower Tuscaloosa Massive Sand Unit.

Figure 2. General Well Completion Design



The CO_2 from the capture facility is anticipated to be at injection pressure and will be transported through well site metering equipment to confirm the rate, pressure and temperature of the CO_2. Deep, subsurface monitoring wells will be constructed similarly to the injection wells. However, the monitoring wells will include additional in-well monitoring equipment, such as pressure, temperature and possible geochemistry probes. The wellhead and subsurface completion profiles are shown in **Figure 2**.

Research Objectives

The Southeast Regional Carbon Sequestration Partnership's (SECARB) Phase III proposed work will focus on the large scale demonstration of safe, long-term injection and storage of CO_2 in a saline reservoir that holds significant promise for future development within the SECARB region. The project will promote the building of experience necessary for the validation and deployment of carbon sequestration technologies in the region. Phase III will continue refining Phase II sequestration activities and will begin to validate sequestration technologies related to regulatory, permitting and outreach. The multi-partner collaborations, developed during Phase I and Phase II, will continue in Phase III with additional support from resources necessary to implement strong and timely field projects.

The Early Test is a saline test that will be conducted in the down dip "water leg" of the Cranfield unit, operated by Denbury Resources in Mississippi. Large volumes of CO_2 can be delivered by Denbury's Sonat Pipeline, which is supplied by abundant natural CO_2 from Jackson Dome. Denbury has recently leased the mineral rights and subsequently unitized the necessary lands (the mineral rights distribution has been approved by the required percentage of working interest owners and royalty owners and the Mississippi Oil and Gas Board). Conducting the Early Test in a saline formation at Cranfield will allow collection of high-quality data from a large volume CO_2 injection test. Importantly, the implementation of the Early Test has been expedited because of readily available CO_2, high quality existing data and pre-acquired property rights and liability arrangements.

In the Early Test, the modeling and monitoring R&D objectives will be to: 1) assess reservoir contact efficiency of the large volumes of CO_2 injected to better quantify CO_2 storage capacity; 2) quantify pressure effects and brine movement though a heterogeneous rock volume to better understand the significance of these on storage capacity and ability to monitor pressure and brine migration; 3) quantify inter-well interactions as large plumes develop, focusing on interaction of pressure, heterogeneity, and gravity as controls on migration; 4) better understand the performance of pressure and capillary seals; 5) develop and assess the effectiveness of existing and novel monitoring tools; and 6) assess how monitoring tools can be used efficiently, effectively, and hierarchically in a long-term monitoring environment.

In the Anthropogenic Test, the R&D objectives will be to: 1) further test the lessons learned at the Early Test, with respect to CO_2 storage, flow and immobilization mechanisms; 2) evaluate injection and storage conditions at a second geographic point in the same regionally extensive saline reservoir to help establish ultimate CO_2 storage capacity; 3) evaluate how best to integrate, and minimize the impacts of,CO_2 capture from a power plant on the operation of transportation and long-term storage; 4) understand how the reservoir architecture (the interplay between the reservoir flow units, seals and baffles) can be used to optimize storage and to minimize the areal extent of the plume; and 5) evaluate the impact of captured CO_2 from power plants on the geochemistry of the saline water in the Lower Tuscaloosa Formation.

Summary of Modeling and MMV Efforts

SECARB is planning an extensive monitoring, measurement and verification program for its field activities. Each site will be well instrumented with multiple sensor arrays. Standard off-the-shelf technologies will be tested in carbon sequestration applications. In addition, novel new tools and techniques will be tested and evaluated. SECARB has proposed an extensive program to monitor performance during the 10-year Phase III project. In addition, the two industry partners who are hosting the injection tests have an interest in supporting MMV activities for extended periods, should that be desired.

Table 1. MMV Objectives, Parameters and Procedures

Measurement Technique	Measurement Parameters & *Equipment*	Application
CO_2 surface flux using mobile chambers, eddy covariance, and dipole laser technique	▪ CO_2 fluxes between the land surface and atmosphere ▪ LICOR CO_2 flux monitors	Detect, locate, and quantify surface CO_2 releases Evaluate ecosystem impacts
Soil gas sampling	▪ In-situ soil gas composition ▪ Isotopic analysis of CO_2 and CH_4 ▪ Sample syringe and gas sample vials	Detect elevated levels of CO_2 Identify source of elevated soil gas CO_2 Evaluate ecosystem impacts
Shallow groundwater composition	▪ TDS, pH, CO_2, HCO_3, CO_3^{2-} ▪ Major ions, trace elements, salinity ▪ Well installation and sampling with peristaltic pumps	Quantify solubility and mineral trapping Quantify CO_2-water-rock interactions Detect leakage into shallow groundwater aquifers
Introduced (PFTs) and natural (isotopes) tracers	▪ Travel time ▪ Partitioning of CO_2 into brine or oil ▪ Identification sources of CO_2 ▪ Modified LICOR gas sampler and NETL portable Cavity Ring-Down Spectrometer and Capillary Absorption Tubes (CAT) and Praxair Seeper Trace ™	Trace movement of CO_2 in the storage formation Quantify solubility trapping Trace leakage
Subsurface pressure and temperature	▪ Storage formation pressure ▪ Shallow formation pressure ▪ Annulus pressure ▪ Groundwater aquifer pressure ▪ Hydrostatic pressure gauges and transducers ▪ Distributed temperature array	Control formation pressure below fracture gradient Measure wellbore and injection tubing condition Trackleakage out of the storage formation
Downhole well logging	▪ Brine salinity ▪ Sonic velocity ▪ CO_2 saturation ▪ Traditional and advanced well logs	Track CO_2 movement in and above storage formation Track migration of brine into shallow aquifers Calibrate seismic velocities for 3D seismic surveys
Vertical seismic profiling and cross well seismic imaging	▪ P and S wave velocity ▪ Reflection horizons ▪ Seismic amplitude attenuation ▪ Traditional VSP	Detect detailed distribution of CO_2 in the storage formation Detect CO2 leakage
Electrical and electromagnetic techniques	▪ Formation conductivity ▪ Electromagnetic induction ▪ Advanced well logging	Track movement of CO_2 in and above the storage formation Detect migration of brine into shallow aquifers

Accomplishments to Date

The project has been selected to move forward by the United States Department of Energy National Energy Technology Laboratory. Efforts to date have involved establishing and negotiating contract terms.

Target Sink Storage Opportunities and Benefits to the Region

The target formation for the SECARB Phase III project is the massive sandstone of the Lower Tuscaloosa Formation (Massive Sand), a Cretaceous age sandstone saline reservoir that occurs in the subsurface along the Gulf of Mexico Coastal Plain from western Florida to Texas (where it is defined as the Woodbine Formation). A type stratigraphic column of the Gulf Coast Region is shown in **Figure 3**.

Figure 3. A Type Stratigraphic Column of the Gulf Coast Region

System	Series	Stratigraphic Unit	Sub-Units	Hydrology
Tertiary	Miocene	Misc. Miocene Units	Pascagoula Fm.	Freshwater Aquifers
			Hattiesburg Fm.	
			Catahoula Fm.	
	Oligocene	Vicksburg		Saline Reservoir
			Red Bluff Fm.	Minor confining unit
	Eocene	Jackson		Saline Reservoir
		Claiborne		Saline Reservoir
		Wilcox		Saline Reservoir
	Paleocene	Midway Shale		Confining unit
Cretaceous	Upper	Selma Chalk	Navarro Fm.	Confining unit
			Taylor Fm.	
		Eutaw	Austin Fm.	Confining unit
			Eagle Ford Fm.	Saline Reservoir
		Tuscaloosa Group	Upper Tusc.	Minor Reservoir
			Marine Tusc.	Confining unit
			Lower Tusc.	Saline Reservoir
	Lower	Washita-Fredricksburg	Dantzler Fm.	Saline Reservoir
			"Limestone Unit"	

The Lower Tuscaloosa contains an upper section of alternating shale and sand and a basal section, the Massive Sand Unit, which contains a thick package of clean, coarse-grained sand. The Formation was deposited during a major period of global sea-level rise and its deposition has been interpreted as an upward gradation from fluvial and deltaic sedimentation (the Massive Sand) to shelf deposition (alternating sand and shale).

The target formation is representative of the geology that could be used to store 50 percent of the CO_2 produced in the SECARB region during the next 100 years.

The Lower Tuscaloosa Formation is a key component of a larger, regional group of similar formations, in terms of deposition and character, called the Gulf Coast Wedge. This wedge of sediments spans the entire region (from the Gulf of Mexico, through Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina and Virginia) and includes some of the largest saline sinks (in terms of areal extent and capacity) for the SECARB region as well as the United States.

Injection tests into the Lower Tuscaloosa Formation will yield confidence in the storage ability of these other Cretaceous and Tertiary basins due to the similar lithologic characteristics, analogous depositional environments, proven seals, and moderately complex structural settings exhibited by all of the six Mesozoic and Cenozoic Formations in the region.

The CO_2 storage capacity of the SECARB region has been recently assessed using conservative methodology set forth by the Geological Working Group's subcommittee on storage capacity. Annual stationary point-source emissions of CO_2 have been estimated to be 1,047 Mt (MIT 2007). Using the range of reported capacity, the Gulf Coast Wedge has the capacity to accommodate these emissions for 300 to 1,200 years, should one hundred percent of this CO_2 needs to be captured and stored.

Cost:	Field Project Key Dates:
Total Field Project Cost: $93,689,241 **DOE Share: $64,949,078** **Non-Doe Share: $28,740,163**	**Baseline Completed:** Early: FY 2008; Anthropogenic: FY 2009 **Drilling Operations Begin:** Early: FY 2008; Anthropogenic: FY 2010 **Injection Operations Begin:** Early: FY 2008; Anthropogenic: FY 2011 **MMV Events:** Early: FY 2008; Anthropogenic: FY 2009

Field Test Schedule and Milestones (Gantt Chart)

Figure 4. General Gantt Chart for the Combined SECARB Phase III Project

	Fiscal Year									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cross-Cutting Activities										
Regional Characterization										
Public Outreach & Education										
Permitting/Regulatory										
Project Assessment										
Project Management & Administration										
Early Field Test										
Public Outreach & Education										
Site Permitting										
Site Characterization and Modeling										
Well Drilling and Completion										
CO2 Procurement (Capture, Purification or Purchase)										
Transportation and Injection Operations										
Operational Monitoring and Modeling										
Site Closure										
Post Injection Monitoring and Modeling										
Project Assessment										
Anthropogenic Field Test										
Public Outreach & Education										
Site Permitting										
Site Characterization and Modeling										
Well Drilling and Completion										
CO2 Procurement (Capture, Purification or Purchase)										
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Site Closure										
Post Injection Monitoring and Modeling										
Project Assessment										